VANGUARD'S DECEMBER 4, 1998, TTY NOTIFICATION PLAN

1. Current Billing Insert

In October and November, 1998, Vanguard included the following notice in all billing statements:

> TTY devices (also knows as TDDs or Text Telephones) allow people who have speech, language, or hearing disabilities to communicate by telephone. TTY devices use a keyboard to enable individuals to type their part of a conversation, which is then transmitted as tones through the telecommunications network. The tones are then transmitted back to text which appears on the recipient's TTY screen. Two types of wireless phones are available -- analog and digital. Some digital wireless phones may operate in the analog mode. Currently, it is possible to place TTY calls using some analog wireless phones. However, TTYs cannot use a digital wireless phone in the digital mode to transmit calls, including calls to 911 emergency services. The Federal Communications Commission requires us to inform you of this existing limitation. Please be assured that we are working with the wireless industry, equipment manufacturers, and representatives of the hearing and speech impaired community to improve the compatibility of digital phones with TTYs.

2. Revised Billing Insert

Effective December 7, 1998, Vanguard is including the following notice with all billing statements:

> **ATTENTION TTY USERS**
>
> TTY devices are not currently compatible with digital wireless phones. If you are a TTY user and are unsure whether your phone is TTY compatible, please contact customer service at 1-800-661-0611 or dial "611" from your CellularOne phone. If you have a digital or dual mode phone, we will replace it with an analog phone at no charge to you. We will also assist you in finding other equipment that will allow you to use your TTY device in conjunction with your new analog phone.

3. Website Posting

Effective December 7, 1998, Vanguard is placing the following notice on its website:

ATTENTION TTY USERS

A TTY (also known as a TDD or Text Telephone) is a telecommunications device that allows people who have speech, language, or hearing disabilities to communicate by telephone. TTY devices include a keyboard that enables people to type their part of a conversation, which is then transmitted in the form of tones through the telecommunications network. The tones are then translated back to text, which appears on the recipient's TTY screen.

TTY devices are currently incompatible with digital wireless telephones. CellularOne is working with the wireless industry, with equipment manufacturers, and with representatives of the hearing and speech impaired community to ensure that digital phones will be compatible with TTY devices. CellularOne will keep its customers fully apprised of the status of these developments.

Certain TTY devices may currently be used with certain analog phones to place wireless calls. If you are a TTY user and are unsure of whether your telephone is TTY compatible, please contact customer service at 1-800-661-0611 or dial "611" from your CellularOne phone. If you currently have a digital or dual mode phone, we will replace it with an analog phone at no charge to you. We can also assist you in finding other equipment necessary to enable you to use your TTY device with your new analog phone.

Customers interested in learning more about TTY devices and their compatibility with analog and digital wireless phones should contact customer service at 1-800-661-0611 or dial "611" from their CellularOne phone.

4. Brochures

The Cellular Telephone Industry Association (CTIA) has developed a model brochure discussing access to wireless telephones for the speech and hearing impaired (attached below). Vanguard will customize the brochure to include the CellularOne logo and add a brief statement that digital phones currently are not compatible with TTYs. Vanguard will begin distributing the brochure at all its retail locations. In the interim, the text of the Revised Billing Insert (see above) will be distributed in all retail locations.

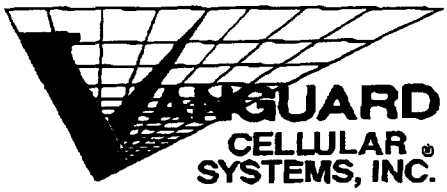
5. Stickers on Digital Handset Packaging

By December 31, 1998, Vanguard will include on all new digital handset packaging a sticker with the following text:

THIS IS A DUAL MODE WIRELESS PHONE.
IT IS NOT COMPATIBLE WITH TTY DEVICES.

6. Letter to All Vanguard Employees

On December 7, 1998, Vanguard will send a letter to all its employees informing them about the TTY/ digital wireless compatibility problem and instructing them on how best to respond to customer queries. The letter is attached below.



(336) 282-3690
FAX (336) 545-2500

2002 PISGAH CHURCH ROAD • SUITE 300 • GREENSBORO, NC 27455

December 3, 1998

Dear Vanguard Employee:

The FCC has recently promulgated several rulings requiring wireless carriers to provide a means for people with speech, language, or hearing disabilities to use TTY devices to make 9-1-1 calls using wireless phones. Specifically, the FCC has ordered wireless carriers such as Vanguard to develop a system through which users can make 9-1-1 calls over Vanguard's digital network using TTY devices.

Although Vanguard has worked diligently with industry representatives and consumer groups, technology has not yet developed to the point where a TTY user can make a 9-1-1 call with a digital phone. Vanguard will continue to work with the FCC and with other interested parties to offer a TTY-compatible digital system. In the interim, it is important that our customers receive correct information about using TTY devices with wireless phones.

Please keep the following points in mind if a subscriber or potential customer asks about using TTY devices with wireless phones:

- A TTY (also known as a TDD or Text Telephone) is a telecommunications device that allows people who have speech, language, or hearing disabilities to communicate by telephone. TTY devices include a keyboard that enables people to type their part of a conversation, which is then transmitted in the form of tones through the telecommunications network. The tones are then translated back to text, which appears on the recipient's TTY screen.

- TTY devices are currently incompatible with digital wireless phones. CellularOne is working with the wireless industry, with equipment manufacturers, and with representatives of the hearing and speech impaired community to ensure that digital phones will be compatible with TTY devices. CellularOne will keep its customers fully apprised of the status of these developments.

- Certain TTY devices may currently be used with certain analog phones to place wireless calls. If you are a TTY user and are unsure of whether your telephone is TTY compatible, please contact customer service at 1-800-661-0611 or dial "611" from your CellularOne phone. If you currently have a digital or dual mode phone, we will replace it with an analog phone at no charge to you. We can also assist you in finding other equipment necessary to enable you to use your TTY device with your new analog phone.

- Customers interested in learning more about TTY devices and their compatibility with analog and digital wireless phones should contact customer service at 1-800-661-0611 or dial "611" from their CellularOne phone.

By communicating these important messages, we can keep our current and potential future customers fully informed of the capabilities of our wireless services as they relate to TTY devices.

Please contact my office should you have any questions.

Sincerely,

Richard C. Rowlenson

Richard C. Rowlenson
Executive Vice President and General Counsel

You

make the choice

If you are a person with a hearing disability, you can make choices that will allow you to access wireless phones and give you options for virtually anytime, anywhere communication.

Unlike traditional wireline phones, with wireless phones, you decide which phone works best for you. You choose the phone, the service provider and any additional features, functions or external devices to create your personal wireless communication tool.

Our *Commitment*

The wireless industry is committed to making wireless phones and technology available to all people, including people who are hard of hearing or deaf, persons with hearing disabilities and persons who wear hearing aids. Wireless service providers and manufacturers are continuing research to find solutions and ensure that quality wireless communications are available for all people.

By promoting education about wireless technology and providing consumers with a variety of solutions, the industry will maximize persons' communication opportunities and choices and create an avenue for education and dialogue between consumers, service providers and equipment manufacturers.

For more information:

CTIA
Building The Wireless Future.
Cellular Telecommunications Industry Association
1250 Connecticut Avenue, NW Suite 200 Washington DC 20036
phone 202-785-0081 www.wow-com.com/consumer

Access

Access to Wireless Phones for Persons who are hard-of-hearing and TTY users

CTIA
Building The Wireless Future.
Cellular Telecommunications Industry Association

www.wow-com.com/consumer

Your solution will be

UniQue

Because of the diversity of hearing disabilities, hearing aids, and types of telephones, there is no single solution to choosing a wireless phone. Being an informed consumer will ensure that you find the right solution available to you.

Explore the different wireless products, services and access solutions offered in your area and determine which combination best meets your personal needs.

There are two basic types of wireless phones — analog and digital. Under most circumstances, analog phones do not interfere with hearing aids. Some digital phones may interfere and cause a buzz when held close to some hearing aids. You should try using the different digital phones to see if you experience any objectionable interference.

No two solutions are alike

Again, the choice is yours. There are numerous styles and brands of phones available. Remember to try the different technologies before purchasing your equipment. The choices you make will enhance the quality of your life and give you limitless opportunities for virtually anytime, anywhere communication.

If you use a hearing aid with a t-coil, you can choose from a number of wireless phones with built-in t-coil coupling capability. A list of wireless phones with built-in t-coil capability is available on CTIA's Website at **http://www.wow-com.com/consumer** Once there, click on the access wireless icon.

If your hearing aid has a t-coil, you should not assume that a wireless phone with built-in T-coil capability is the only solution for you. You may discover that using a phone with increased volume control or a combination of any of the solutions discussed below may give you optimal use of your wireless phone.

If you use a TTY, some analog phones may be compatible with your TTY. If your TTY has direct connect capabilities, an RJ-11 intelligent interface is available that may allow you to connect your wireless phone directly to your TTY.

External devices that may enhance your ability to use a wireless phone are also available. One type of device acts as an external t-coil coupling device and directs the telephone signal into the hearing aid's t-coil. Another device, similar to a Walkman earplug, requires you to place the speaker into your ear in place of a hearing aid and provides for better reception in noisy environments. Also available are portable amplification devices which fit over the earpiece of many phones and increase the volume beyond the phone's volume control capabilities.

If you have difficulty hearing your phone ring, there are phones with built-in vibrating alerts, vibrating batteries that can be added to some phones, and wireless units programmed to vibrate when your wireless phone rings.

If you require volume control, you can make the choice among many wireless phones which offer a volume control option.

Vanguard's Timetable for Implementing Section 20.18(c)[1]

Date	Milestone
	PHASE I -- FIRM DEADLINES
10/98 - 11/98	Notify customers of TTY limitations through monthly billing inserts.
11/15/98 - 12/31/98	Design and implement expanded notification plan, including billing insert, Website posting, CTIA Brochure dissemination, digital handset stickers, and letter to all employees.
11/20/98 and ongoing	Initiate regular status update meetings with phone manufacturers, TTY device manufacturers and Nortel; schedule on-going monthly meetings.
By 12/31/98	Create and activate TTY Project team, including representatives from Engineering, Customer Operations, Customer Service, Customer Activations, Information Services, Sales, Training, Distribution, Billing, Financial Services, and Legal departments.
1/1/99 - 1/31/99	Evaluate product proposals (or status reports) from telephone manufacturers, including IWF, V.18, and proprietary solutions, and conduct technical review to determine preferred long-term solution.
By 1/15/99	Meet with Richard Uzuanis, Vice President of HITEC (a distributor of products for the hearing impaired), to discuss call center operation and product availability.
By 1/31/99	Review Standardized Test Plan and update to conform with Vanguard specifications.
By 3/1/99 and ongoing	Report to FCC as to progress being made toward implementation of TTY/ digital wireless capability. Continue reports quarterly or upon any significant deviation from Timetable or other significant development.
	PHASE II -- PROJECTED FROM DATE OF PRODUCT AVAILABILITY
30 days	Field test product prototype to ensure compliance with FCC Order and with applicable consumer concerns.
45 days	Determine network performance benchmark (i.e., switch compatibility) using solution equipment.
60 days	Review test results and initiate commercial product/package development.
90 days	Begin Sales and Support product training.
120 days	Procure commercially ready product, perform final testing, and distribute product to all retail locations.
120 Days from date of product availability	**MAXIMUM TIME TO IMPLEMENT COMMERCIAL PRODUCT**

1 Implementation of the Timetable is contingent upon the approval and consummation of Vanguard's pending transfer of control application. *See* Vanguard Cellular Systems, Inc. and Winston, Inc. Seek Consent for Transfer of Control, Public Notice DA 98-2320 (rel. Nov. 13, 1998).

WIRELESS TTY FORUM

Seeking Solutions to TTY Through Wireless Digital Systems

QUARTERLY STATUS REPORT

Submitted by:

The Cellular Telecommunications Industry Association (CTIA)
Consumer Action Network (CAN)
Gallaudet University
National Association of the Deaf (NAD)
Personal Communications Industry Association (PCIA)
Telecommunications for the Deaf, Inc. (TDI)

October 13, 1998

INTRODUCTION

The Wireless E911/TTY Forum 6, 7, and 8 convened in Washington, D.C. on July 21-22, 1998, September 7-8, 1998, and October 7-8, 1998, to continue collaborative efforts to provide viable solutions for TTY access to 9-1-1 over digital wireless systems.[1] This quarterly status report documents the progress of the Wireless TTY Forum over the past three months. Specifically, the Wireless TTY Forum is in the process of finalizing a uniform test methodology to compare character error rates across the various digital wireless technologies. Several members of the TTY Forum have conducted and submitted additional test results to determine: 1) whether digital wireless technologies and Baudot TTY devices can achieve a character error rate comparable to a character error rate for analog cellular and Baudot TTY devices, *i.e.*, less than 1%; 2) whether modifications to digital wireless handsets and TTY devices are necessary to achieve a character error rate comparable to CER for analog cellular; and 3) whether standardization of the audio input and output levels in the digital wireless handset and the Baudot TTY can provide optimal results for TTY users.

The TTY Forum also has continued its efforts in developing a technical information document ("TID")for direct electrical connection. A revised proposal of this modified voice based solution will be submitted to the appropriate standards-setting body in the near future. Meanwhile, the TTY Forum will make available the TID for those carriers that prefer a solution via direct electrical connection. The TTY Forum has also reviewed several proposals for data solutions. While these solutions are very promising, they require modifications to the network infrastructure. It appears that several proposed data solutions require the development of software, input from Inter-Working Function manufacturers, and the development of standards. The TTY Forum is in the process of finalizing a workplan that will provide scheduled milestones for the development and implementation of data solutions as well as voice based solutions.

In response to the Commission's recent Order granting a 45-day extension of the compliance date, TTY Forum 8 primarily focused on finalizing the test plan and a workplan with scheduled milestones. While the workplan addresses consumer concerns, the goal of the TTY Forum is to achieve consensus of the workplan by all members of the TTY Forum. In accordance with the Commission's mandate, the final test plan and workplan will be filed with the FCC by October 30, 1998.

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[1] The TTY Forum Meetings were held on the following dates: September 17-19, 1997; December 11-12, 1997; February 11-12, 1998; April 1-2, 1998; May 20-21, 1998; July 21-22, 1998; September 8-9, 1998; and October 7-8, 1998. Subsequent meetings are scheduled for November 4-5, 1998, in the Washington, DC or Baltimore area.

I. TEST METHODOLOGY

The July1998 Quarterly Status Report indicated that the combined Working Group #1/#3 had developed an objective test procedure designed to evaluate the "throughput" error rate of 45. 5 baud Baudot TTY devices over wireless telephone links ("Throughput Test").[2] It has been clarified that Working Group #1/#3 developed a *standardized test script* to help evaluate the character error rate of 45.5 baud Baudot TTY devices transmission over a wireless air interface. Several equipment manufacturers and one TTY manufacturer (Lober & Walsh Engineering, Inc.) have used the standardized test script in their testing. Preliminary test results showed wide variations in the percentage of character error rate for different digital technologies.[3]

At the TTY Forum Meeting held July 21-22 1998, several Forum members expressed concern that the wide variance in the test results reported at the May 1998 TTY Forum Meeting may be contributed to inconsistent test methods, inconsistent methods of evaluating test results among the various manufacturers, and inconsistent performance of various TTY equipment. There was also considerable discussion concerning an assessment of the test results to date by an independent third party. The TTY Forum members agreed that Dr. Dale Hatfield, Chief of the FCC's Office of Engineering and Technology, would be the appropriate person to conduct this assessment.[4] At the September 1998 TTY Forum, the co-chair of the Forum acknowledged the need for the development of a consistent test methodology, a uniform method of evaluating the test results ("test plan") and TTY performance standards to determine the minimal level of character error rate that TTY users can expect with certain digital technologies used with certain TTY devices.

Since the September 1998 TTY Forum, the wireless industry has reviewed the initial test

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[2] See In the Matter of Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems, CC Docket No. 94-102, Wireless TTY Forum: Seeking Solutions to TTY Through Wireless Digital Systems, Quarterly Status Report, 2-3, filed July 10, 1998 ("July 10, 1998 Quarterly Status Report").

[3] For CDMA technology, initial tests revealed a character error rate from 6% to 16%. For TDMA technology, initial test results revealed a character error rate from 2% to greater than 10%, and for GSM technology, 2% to 4% character error rate. The percentages varied depending upon a number of variables such as test conditions (laboratory vs. actual network), vocoder rate, fixed location vs. mobile, performance of TTY equipment, etc. See July 10, 1998 Quarterly Status Report at 2-3.

[4] On August 4, 1998, CTIA, on behalf of the TTY Forum, met with Dr. Dale Hatfield, Bruce Franca, and Marty Liebman to request Dr. Hatfield's independent review and assessment of the tests conducted and presented at the TTY Forum from September 1997 through July 22, 1998. It was anticipated that Dr. Hatfield would provide guidance to the TTY Forum on the soundness of the research already conducted and would identify any discontinuity or gaps in such research that should be explored in the development of a consistent test plan.

results and has concluded that additional testing would not yield new or significant information on character error rates. The wireless industry has acknowledged that there does not appear to be a voice-based solution in the near future which will allow the Baudot signal of a TTY device to pass through the vocoder of a digital air interface and achieve a character error rate comparable to the character error rate achieved with analog air interface, *i.e.*, less than 1%. Accordingly, the wireless industry would prefer to spend their limited resources and time on developing technically feasible data solutions to achieve access for TTY users over digital wireless systems.[5]

Consumer groups expressed their concern that data solutions may not address the immediate need of Baudot TTY users to access 9-1-1 over digital wireless systems. They support the concept of data solutions that provide faster and better transmission than the Baudot signal transmitted over digital wireless voice channel. The consumer groups, however, are concerned that the embedded base of Baudot TTY users would have very few or no alternatives to access 9-1-1 over digital wireless systems while they wait for the commercial availability of data solutions. While the wireless industry is reluctant to conduct further testing to assess character error rates, the Commission issued an Order requiring the TTY Forum to finalize and submit the test plan to the Commission by October 30, 1998.[6] The Commission expects that members of the TTY Forum will conduct further testing in accordance with a standardized test plan.

At the September 1998 TTY Forum, LWE presented a draft test procedure to assist the TTY Forum in developing a standardized test plan.[7] LWE's draft test procedures established a standardized test for measuring the performance of TTY devices over cellular and PCS networks in a lab setting and field environment. In its presentation, LWE indicated that the majority of field tests could be done in a lab simulating field results. If lab performance of the digital handset and TTY device cannot achieve a character error rate comparable to the character error rate achieved over analog (less than 1%), then testing should not be conducted in the field. Josh Lober of LWE stated that the draft test procedures define a configuration in which a TTY device can be objectively tested over any cellular or PCS network. After considerable discussion and technical analysis, there was consensus that the TTY Forum would accept LWE's draft test procedures as the basis of a standardized test plan. An ad hoc working group was established to

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[5] The CDMA Development Group ("CDG") has indicated that it has a "good understanding of how the characteristics of CDMA affect TTY/TDD performance and believe it is important to focus resources on developing solutions, versus performing additional tests." Moreover, the CDG has assured the TTY Forum that it "will ensure consistency of conditions and assumptions in evaluating candidate solutions." Letter from Mr. Jim Takach, Program Manager, CDMA Development Group, to Ms. Andrea Williams and Mr. Ed Hall, Cellular Telecommunications Industry Association, Sept. 8, 1998. Attached hereto as Appendix A.

[6] See In the Matter of Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems, Order, CC Docket No. 94-102, DA 98-1982, released Sept. 30, 1998 ("Extension Order").

[7] See Lober & Walsh, TTY Over Cellular and PCS – Test Procedure, Sept. 2, 1998; Lober & Walsh, *et al.*, TTY Over Cellular and PCS Field Test Procedure, Sept. 2, 1998. Attached hereto as Appendix B.

finalize a standardized test plan using the LWE draft test procedures and to distribute the test plan to the wireless digital technology groups (CDG, UWCC, GSMNA, Motorola (iDEN)) for modifications appropriate to their respective digital air interfaces.[8]

At the recent TTY Forum Meeting, there was discussion among members of the ad hoc working group concerning review of the standardized test plan prior to its release to the wireless digital technology groups. The version distributed to the technology groups did not include the ad hoc working group's recommended revisions.[9] The ad hoc working group will address and resolve expeditiously so as not to delay finalization of the test plan by October 30, 1998.

II. ADDITIONAL TEST RESULTS

Lober and Walsh Engineering, Inc. ("LWE") has conducted a series of tests since May 1998, to assist the TTY Forum in its efforts to develop technically feasible solutions for TTY access over digital wireless systems. LWE test data indicated that reliable conversation could be achieved sending a Baudot signal over a digital air interface, *provided that* certain modifications are made or certain conditions exist to minimize the character error rate. While LWE has conducted tests on TDMA phones over IS-136 digital systems and the Motorola i600 phone over an iDEN digital system, LWE has not conducted any tests on CDMA technology.[10]

A. LWE's Initial TDMA Test Results

At the July 1998 TTY Forum Meeting, LWE provided its test results of TTY devices

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[8] The draft test plan is currently under review by each wireless digital technology group and Motorola (iDEN).. Any modifications made by them to the test plan are to accommodate their respective digital technologies. Thus, the test methodology should not change. Upon receipt of the modifications, the ad hoc working group which represents the TTY Forum will review the modifications and finalize the test plan for submission to the FCC by October 30, 1998. If a wireless digital technology group fails to respond to the chair of the ad hoc working group by October 30, 1998, the co-chairs of the Wireless TTY Forum will provide the FCC with the appropriate name and number to contact at the wireless digital technology group.

[9] Specific issues include revisions on the scoring, some of the test procedures could contribute to the length and cost of testing, terminating the call in the PSTN rather than on lab equipment and whether other modifications could e made to shorten the time required to conduct the test still need to be resolved.

[10] It was noted at the September 1998 TTY Forum Meeting that LWE has not conducted any tests with CDMA technology, and that there is no technical reason why intercharacter delay would improve CDMA performance. While some Forum members indicated that it would be interesting to see the results of full transmission rate and slowed transmission rate of Baudot signal over all air interfaces, other members concluded that intercharacter delay would not be beneficial for CDMA technology. See TTY Forum, Seeking Solutions to TTY/TDD Through Wireless Digital Systems, TTY/TDD Forum – 7, Final Report , Oct. 1998, 13 ("TTY Forum 7 – Final Report"). Attached hereto as Appendix C.

(45.5 Baudot) over a live IS-136 (TDMA) digital network using digital (TDMA) phones provided by three equipment manufacturers.[11] The test data indicated that reliable conversation from a stationary location and from a moving vehicle with good signal strength can be achieved sending a Baudot signal over an IS-136 digital air interface under certain conditions, *e.g.*, introduction of character delays, development of TTY performance standards, power level commands of the digital wireless handset. With respect to character error rate, test results varied depending on the quality of the "land side" and "mobile side" TTY's FSK receiver.[12] LWE concluded the following based on its initial research and test results:

- Introducing inter-character delays can reduce character errors.
- High character error rates result from "low quality" cellular connection.
- The lack of performance standards for TTY devices is an impediment to good transmission.
- Hand-off commands and power level commands also result in increased errors.
- Vocoders are known to distort the Baudot waveform. The time domain is affected by adding "pops" in amplitude thereby increasing the dynamic range of the FSK waveform. The frequency domain is not affected greatly.
- Due to the variance in the quality of TTYs in the field today, it is not possible to ensure acceptable character error rates without replacing or "enhancing" existing TTYs.[13]

LWE has developed a proprietary, "enhanced" TTY device, Cellular Products Technology Mobility™ TTY, which it used in its tests. The test results presented by LWE indicate that the Mobility™ TTY will help improve the transmission of Baudot signaling over digital wireless systems with minimal character error rate if installed at one end of a communications link. Transmission would improve more if a Mobility™ TTY or a quality TTY device is available at both ends. LWE has indicated that it may develop a "retrofit module" to use with existing TTY devices in order to provide better performance between existing TTY devices and digital wireless technologies.

There was considerable discussion from other TTY manufacturers concerning LWE's test results and its conclusions concerning performance standards, or lack thereof, for existing TTY devices. Technical experts at the TTY Forum 6 Meeting also discussed the scoring method used

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[11] TDMA phones provided were *Aeon* (Philips Consumer Communications), Digital Talk 2000 (NEC of America), and Motorola (M70A).

[12] LWE used its Mobility™ TTY and three "landside" TTYs (Ultratec's Compact, EZCom Pro and Superprint as well as Ameriphone Dialogue). See Cellular Product Technologies, LLC. Test Results for TTY/TDD Over Live Digital Cellular Networks, July 21, 1998 ("LWE Initial Test Results"). Attached hereto as Appendix D..

[13] See LWE Initial Test Results at 11-13.

by LWE. Specifically, they questioned whether there should be a maximum of eight errors scored for a missed shift character. There was also concern that the original script had unrealistically high numbers of character errors. It was determined that the best way to proceed on this issue was to generate a new test script.[14] The script should contain multiple shifts space apart so that a realistic distribution of character errors would result, based on the frequent practice of correcting shift errors by user action. Accordingly, LWE developed an appropriate test script to ensure no more than a maximum of eight errors for a missed shift character.

B. LWE's TDMA Test Results – Version 1.0

In late July 1998, LWE conducted additional field tests with the new test script and a NXi Communications TTY Modem (model 300vi). The NXi TTY Modem is used with a personal computer and sold for use in commercial, residential and PSAP applications. This supplemental testing was a continuation of the previous tests presented at TTY Forum 6.[15] Test results indicated a 1% average character error rate for digital calls and .01% average character error rate for analog calls. In its report, LWE noted that these results are comparable to the stationary half rate CER results of .88% in the earlier tests. LWE concluded that these test results provide additional support that the quality of the "landside" TTY varies between TTY manufacturers, and there is a need to specify minimum performance requirements of a TTY device, particularly for use in a PSAP facility.[16]

C. LWE's TDMA Test Results – Version 1.1

During August and early September 1998, LWE conducted another series of tests evaluating its Mobility™ TTY connected to various IS-136 digital cellular phones (Motorola M70A, NEC Digital Talk 2000, Philips *Aeon* and Ericsson DH368vi).[17] For these tests, LWE

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[14] LWE generated a new test script and circulated it via electronic mail to all TTY Forum members for feedback. No feedback was received. Thus, LWE assumed the new script was acceptable and proceeded to re-program its Mobility™ TTY with the new test script for further testing. Gallaudet University also circulated a new test script for consideration and received no feedback. Consumer representatives indicate that the issue of test script has not been resolved. They are concerned that the insertion of an unrealistically high number of character shifts may inflate error rates. Gallaudet University has also requested free wireless service and equipment for the various digital wireless technologies used in the Washington DC area, in order to examine CER in the field under various user conditions.

[15] LWE performed the tests from the same stationary location, using the same phones, over the same network. Baseline tests were performed over an analog network to verify operation under "normal" conditions.

[16] See Cellular Product Technologies, LLC. Test Results for TTY/TDD Over Live Digital Cellular Networks, Supplemental Report, July 31, 1998 ("LWE Supplemental Test Report I"). Attached hereto as Appendix E.

[17] See Lober & Walsh Engineering, Inc. TTY Over IS-136 Digital Cellular, Supplemental Test Report, Sept. 3, 1998 ("LWE Supplemental Test Report II"). Attached hereto as Appendix F.

used Ultratec's Intele-Modem[18] and NXi Communications 300vi on the landside. Tests were performed using a full character delay between each character sent,[19] with consideration of the different algorithms in the various digital phones.[20] Test results indicated an average character error rate of 1% with excellent performance during stationary 1/2 and 3/4 transmission rate.[21]

LWE concluded that matching the audio levels and receiver dynamic ranges between the TTY device and the phones is the key to better interoperability between TTY devices and wireless phones. LWE also encouraged device manufacturers to work together to determine the optimum audio levels between equipment, and make the necessary adjustments. LWE's research also indicated that the dynamic range can be minimized if the audio levels are properly matched and configured.[22]

Gallaudet University expressed grave concern regarding slowing down the TTYs transmission rate to improve the character error rate. Consumer groups stated that slowing the TTY transmission down to half rate is highly undesirable because it slows down the transmission of the 9-1-1 message. Moreover, such a solution would require retrofitting all wireline TTYs, including PSAPs' TTYs. Consumer groups noted that to achieve compliance, carriers should not rely upon reduction of the transmission rate.

D. LWE iDEN Test Results

At the September 1998 TTY Forum Meeting, LWE presented test results for TTY devices

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[18] The Ultratec Intele-Modem device connects to a personal computer via an RS-232 serial port. In its test report, LWE noted that test results from the Ultratec Intele-Modem device are not representative of other Ultratec TTY devices tested by LWE. LWE explained that the technology used in the Intele-Modem is different from technology in other Ultratec TTY devices examined by LWE. According to LWE, the Intele-Modem cannot directly connect to a wireless phone without modification. See LWE Supplemental Test Report II at 9.

[19] In its previous test reports, LWE determined that improved CER performance could be achieved when delays were placed between each character transmitted. With a BIT duration at 45.5 Baud of 21.98mS, the delay reduces the word per minute ("wpm") rate from 68.25 wpm to 34.14 wpm, based on five character words. LWE also determined that a delay equal to three BITS in length is sufficient and has the effect of reducing the wpm rate from 68.25 wpm to 49.64 wpm. See LWE Initial Test Results at 11; LWE Supplemental Test Report I at 3.

[20] LWE notes that several digital wireless phones have different algorithms which affect the way the Baudot tones are passed over the various digital air interfaces. LWE's test data indicates that the Baudot tones are passed differently through different types of IS-136 digital phones.

[21] See LWE Supplemental Test Report II at 21.

[22] See LWE Supplemental Test Report II at 14.

over an iDEN network using the Motorola i600 iDEN wireless handset. Tests were performed in the mobile to land direction only from a stationary location. LWE connected the i600 phone directly to the Mobility™ TTY. The landside connection used three different TTY devices: Mobility™ TTY, the NXi Communications 300vi TTY modem, and Ultratec's Intele-Modem. These tests also were performed using a full character delay (three BIT delay) between each character sent, thus reducing the word per minute rate from 68.25 wpm to 49.64 wpm (based on five character words).[23]

LWE's test results indicated excellent performance during stationary 3/4 rate CER tests. LWE noted that the i600 digital wireless phone is to a greater extent more sensitive to audio levels, and care must be taken to match the audio levels in the TTY to the levels in the phone. LWE concluded that iDEN technology appears to be capable of carrying reliable TTY communications over its digital voice channel, provided the audio levels in the TTY device and the handset are properly configured.[24]

E. Nokia's Test Results in Laboratory Environment

Nokia, Inc. has conducted additional laboratory tests in an effort to isolate and identify the source of character errors between TTY devices and TDMA (IS-136) technology.[25] Using a base station simulator and Ultratec's TTY devices (Supercom 4400 and Uniphone 1140) at both ends, Nokia tested its 6160 dual-mode (analog/TDMA (IS-136)) handset. They tested only the down link which represents a "worst case" scenario. The sensitivity level was specified between –116 dBm and –113 dBm. RSSI was modified from –50dBm down to the sensitivity levels. No fading or network effects were added.

In the analog mode, Nokia entered data slowly and manually. It decreased the RSSI from –50dBm down to –116 dBm. In its report, Nokia explained that character error rate can be increased by decreasing the frequency deviation and decreasing the RSSI down to sensitivity levels. Test results showed that a slight mismatch in peak deviation can adversely affect the character error rate. Nokia noted that the character error rate increased rapidly at and beyond the sensitivity levels, and primarily was due to an expanding high attack time. The high attack time caused the receiver to completely miss the start bit which was more profound near sensitivity levels. Based on signal strength level, the character error rate in the analog mode ranged from 0% to approximately 19%.[26]

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[23] See Lober & Walsh Engineering, Inc. TTY Over Digital Cellular, Test Report – iDEN Technology, Sept. 5, 1998 ("LWE iDEN Test Report"). Attached hereto as Appendix G

[24] LWE iDEN Test Report at 15.

[25] While Nokia's test report was not discussed at the October 1998 TTY Forum Meeting, it was provided to Forum members for review and comment. See Nokia, Inc., TTY-Wireless Phones Laboratory Tests, Oct. 8, 1998 ("Nokia Lab Tests"). Attached hereto as Appendix H.

[26] Nokia Lab Tests at 3, 7.

Similar tests were conducted with the Nokia 6160 handset in digital mode. Test results indicated that residual character error rate is approximately 2% to 7% at high RSSI levels and most likely reflects the vocoder's effect on the character error rate. Nokia noted that a large percentage of the errors were due to missing the character start bit. Based on the RSSI in –dBm, character error rate in the digital mode ranged from approximately 2% to approximately 38%.[27]

F. Philips Test Results on a Live Network

In its effort to characterize TTY performance over a live IS-136 digital wireless network, Philips has conducted additional tests since the September 1998 TTY Forum.[28] Using the Philips *Aeon* TDMA digital wireless handset with the LWE Mobility™ TTY and Ultratec's Intele-Modem, calls were made on a live IS-136 network from an average signal strength fixed location. In its test report, Philips provided a comparison of test results that calculate the true character error rate and the rate including shift error.[29]

Based on its test results, Philips concluded that shift errors play a significant role in CER. The CER was worse when shift errors were included, particularly when using a TDMA digital channel. Although there was no notable difference between half rate and full rate transmission of the Baudot signal over analog voice channels, half rate transmission appeared to improve performance when the LWE Mobility™ TTY was sending. Philips attributed the improved performance with the LWE Mobility™ TTY to the way it sustains the space tone during pauses.[30] Philips also concluded the following:

- When communicating between similar TTY devices on digital TDMA channels, the CER averaged approximately 2% to 3%. Performance over analog channels averaged approximately 1%.

- Inconsistent audio levels between the TTY devices may result in increased CER. Philips recommends standardization of audio levels at the interface between the TTY and digital wireless phone to correct this problem.

- While field testing provides an opportunity to observe performance under real-life conditions, field conditions do not provide the controls necessary to produce consistent and "repeatable" test data. Thus, field data should be used prudently.

- Laboratory testing is necessary for consistent, "repeatable" test results. Philips recommends adaptation of the LWE test methodology for use at quality test

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[27] Nokia Lab Tests at 4, 8. See also, Nokia Lab Tests at 9-12 (analysis of test data).

[28] See Philips *Aeon* TTY Interoperability Test Report, Version 1.1, Oct. 2, 1998 ("Philips Test Report Version 1.1"). Attached hereto as Appendix I.

[29] Philips Test Report Version 1.1 at 6.

[30] Philips Test Report Version 1.1 at 7.

laboratories.[31]

III. TTY DEVICES

Over the past several months, there has been significant discussion concerning the lack of performance standards of TTY devices. Manufacturers of wireless handsets have indicated that such standards are critical in trying to address the technical challenges of "backward compatibility."[32] Gallaudet University provided the TTY Forum with a copy of an initial effort in the 1980s by Electronic Industries Association ("EIA") to develop a voluntary industry standard for TTY devices. Unfortunately, the TTY manufacturers at that time "seem[ed] unwilling or unable to agree on the terms of the standard."[33] There was discussion as to whether any TTY manufacturers used the June 1986 version of the draft standard. If so, the document would be very helpful in facilitating interoperability between TTY devices and digital wireless handsets. The TTY Forum discussed the need for a list of "most often used" TTY devices and specifications for each device if TTY manufacturers are not using the EIA draft standard.

IV. MODIFIED VOICE-BASED SOLUTION – DIRECT ELECTRICAL CONNECTION

The TTY Forum does not support one solution over others. However, it appears that coupling via a direct electrical connection between the TTY device and a digital wireless handset, *i.e.*, a 2.5 mm audio interface, is a preferred solution. At the October 1998 TTY Forum, Lee Whritenour of Bell Atlantic Mobile submitted a proposal for a wireless phone 2.5mm audio interface to TTY devices.[34] The proposal noted that audio output and input levels are different for each make and model phone. Thus, manufacturers of wireless phones would need to provide a special adapter with standard levels. Moreover, audio output and input levels of TTY devices have yet to be defined. The proposal recommended a "common interface" to resolve the variance in output and input levels.[35]

The proposed common interface has several advantages. For example, it does not require changes to the wireless manufacturer's current headset and adapter. A switch on the common interface allows for TTY and VCO/HCO operation by using the phone manufacturer's headset

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[31] Philips Test Report Version 1.1 at 10.

[32] For purposes of this discussion, "backward compatibility" is defined as passing the Baudot signal of TTY device over a digital air interface without any modification to the handset or the TTY device.

[33] See Electronic Industries Association, Memorandum to Parties Interested in EIA Standards Project PN 1663, Telecommunications Devices for the Deaf, May 16, 1988, 1. Attached hereto as Appendix J.

[34] See Proposed - Wireless Phone 2.5mm Audio Interface to TTY/TDD ("2.5mm Audio Interface Proposal"). Attached hereto as Appendix K.

[35] See 2.5mm Audio Interface Proposal at 3-4.

that is designed for the phone. Notwithstanding these advantages, additional information is necessary to develop this solution. The proposal invites comments and additional information from manufacturers on several issues. Specifically, what is a usable input/output audio level from the common interface to the TTY? What are the optimum levels to drive the vocoder of the digital wireless phone as well as other circuitry? What are the expected audio levels at the PSTN, and are they optimized for the needs of the receiving TTY?[36]

V. DATA SOLUTIONS

The TTY Forum is still in the process of finalizing the Draft Standards Requirements Document for Circuit Switched Data for submission to the appropriate standards-setting body. Meanwhile, Qualcomm and Philips Consumer Communications ("Philips") have focused efforts on developing data solutions to address TTY access over CDMA digital air interface.

A. Qualcomm's Proposed Hybrid Solution for CDMA Technology

At the TTY Forum 7 Meeting, Qualcomm presented a White Paper proposing a hybrid data solution in which data is sent over the CDMA digital air interface and then converted back to analog.[37] Qualcomm proposed using data bits rather than the vocoder to pass the Baudot signal over digital wireless networks. Since digital networks can relay data bits without any TTY modulation, Qualcomm explained that it is unnecessary for the TTY device to convert these bits into tones before entering the digital network.

Qualcomm's proposed solution requires an Inter-Working Function ("IWF") within the network that will convert data bits received from the mobile handset into TTY tones for the PSTN, and in the reverse direction, convert TTY tones received from the PSTN into data bits sent to the mobile handset. Essentially, the IWF is a modem pool located between the wireless network and the PSTN to support wireless data services. Employing an IWF in the CDMA network infrastructure requires either a software upgrade to existing infrastructure or adding a separate modem pool through a standardized interface such as IS-658.

The proposed solution supports the use of error correction protocols to reduce significantly the character error rate. An IWF can support not only TTY applications, but also provide high-speed data modem services, facsimile services and direct Internet access. According to Qualcomm, the existing IS-707 standard for CDMA data services has the necessary options to support TTY and any other V.18 modem. While the hybrid solution may not require modifications of standards, implementation of this solution is very dependent on IWF manufacturers. Qualcomm indicates that the IS-707 TTY Baudot option has to be selected in the IWF, which will require IWF manufacturers to upgrade their IWF software to support TTY Baudot modems. Moreover, a wireless carrier using CDMA technology will have to deploy at least one IWF in each of its service areas. While Qualcomm indicates that CDMA IWF manufacturers appear willing to address the necessary upgrades, there is no indication as to when

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[36] See 2.5mm Audio Interface Proposal at 5.

[37] See A CDMA Data Solution for Reliable TTY/TDD, Sept. 1998 ("Qualcomm White Paper"). Attached hereto as Appendix L.

such upgrades can be developed, installed and deployed throughout the CDMA network infrastructure.

The proposed hybrid solution does not support VCO/HCO. The Qualcomm White Paper provides a brief summary of the technical challenges associated with VCO/HCO access via CDMA technology.[38] Qualcomm acknowledges that supporting VCO/HCO will require significant changes in the CDMA network infrastructure, and will require substantial time for development and implementation. Thus, VCO/HCO access over CDMA technology will not be available for quite some time.

B. Philips' Proposed Solutions for CDMA Technology

At the September 1998 TTY Forum Meeting, Philips submitted two proposals that recommends solutions for transmitting TTY Baudot text over the CDMA digital air interface. The first proposal advocates the development of a new service option using the EVRC vocoder to provide simultaneous voice and dedicated user data on a CDMA fundamental traffic channel.[39] According to Philips, this proposed service option is a long-term, network solution and has distinct advantages. First, it has the capability to provide data and messaging features. Second, the proposed solution may ensure data transport in combination with a full rate voice channel whereby data can be conveyed continuously without interruptions. Finally, Philips indicates that this proposed service option should be able to support VCO/HCO over a single CDMA fundamental traffic channel. While this proposal has been submitted to the appropriate Standards Committee, TIA TR45.5, it has been remanded to TR45.5 Working Group I for review. Philips estimates that it could take approximately 18 to 24 months for the development of a standard. Subsequently, manufacturers may begin the process of developing a commercially available product.

The second proposal defines a methodology that can provide nearly error-free transmission of TTY FSK Baudot text over CDMA digital air interface.[40] Philips states that this proposal can be implemented in the existing CDMA network without requiring a modification of standards. Although it characterizes the proposal as "relatively simple" to implement, Philips acknowledges that its second proposal may require changes in the mobile handset and the network. Specifically, Philips notes that implementation of a Baudot signal detector, decoder, and encoder in the handset or the network infrastructure will be necessary. While Philips anticipates that this proposed methodology could minimize CER to an acceptable rate, the software necessary to implement this proposal has not been developed. Philips also

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[38] See Qualcomm White Paper at 4.

[39] See Philips Consumer Communications. Request for Project Number to Support Development of a Service Option to Provide Simultaneous Voice and Data Transport on a CDMA Fundamental Traffic Channel, Aug. 17-21, 1998. Attached hereto as Appendix M.

[40] See Philips Consumer Communications. A Proposed Method to Improve TTY Reception Over Wireless Links Without Requiring Standards Changes, Aug. 17-21, 1998. Attached hereto as Appendix N.

acknowledges that at this time it could not provide a definitive time table for commercial availability of a product.

VI. VCO/HCO ISSUES

Mr. Peter Lee of Ameriphone discussed the implications of a built-in microphone and receiver on the handset for HCO/VCO applications. While Ameriphone endorsed the direct electrical connection approach, *e.g.*., 2.5 mm jack, it noted that this approach may not be the most ideal solution for VCO/HCO applications. Mr. Lee explained that each application requires the use of either a microphone or a receiver. Ameriphone proposed that a TTY user should be able to selectively enable the handset's microphone or receiver for VCO/ HCO use.[41] At TTY Forum 7, there was consensus that where possible, VCO/HCO should be included in the testing, design, and availability of TTY devices and digital air interface technologies.[42]

Self Help for the Hard of Hearing ("SHHH") has attempted to gather statistics on the use of VCO/HCO. SHHH's representative indicated that it has been a daunting task with little or no reliable data available, and he did not want to underestimate the population of VCO/HCO users. He suggested that there is a need for a reliable study of the VCO/HCO population. SHHH, unfortunately, does not have the funding at this time to conduct such a study.

VII. CONSUMER CRITERIA DOCUMENT

At the TTY Forum 6, the CDG requested clarification of several issues in order to develop viable solutions to support TTY access to 9-1-1 over CDMA digital air interface.[43] In response to the CDG's and TTY Forum's requests for clarification the consumer representatives of the TTY Forum provided a document titled "Consumer Approved Criteria for Acceptance of 'One Phone Model Per Service Provider as of October 1' Proposal" ("Consumer Criteria Document"). The purpose of the document was to stimulate discussion and solicit the views of the wireless carriers and manufacturers participating in the TTY Forum. At the September 1998 TTY Forum Meeting, CTIA, on behalf of its members, submitted its comments to the criteria set forth in the Consumer Criteria Document.[44]

In its response, CTIA noted that while the "One Phone Model Per Service Provider" proposal was moot with respect to compliance by October 1, 1998, many criteria implicated marketing, advertising and customer care issues and pending regulatory issues before the FCC. CTIA invited the drafters of the Consumer Requirement Document to meet with CTIA's senior

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[41] See Letter from Mr. Peter Lee, Vice President of Engineering, Ameriphone, to Mr. Ed Hall, Chair, CTIA Forum, Sept. 3, 1998. Attached hereto as Appendix O.

[42] See TTY Forum – 7 Final Report at 27.

[43] See CDG Contribution to CTIA TTY/TDD Forum 6, July 21, 1998. Attached hereto as Appendix P.

[44] Letter from Andrea Williams, Assistant General Counsel, Cellular Telecommunications Industry Association, to Ed Hall and Mary Madigan, Co-Chairs, Wireless TTY Forum, Sept. 8, 1998. Attached hereto as Appendix Q.

staff to address the criteria in the context of CTIA's inter-disciplinary approach to accessibility under Section 255. CTIA explained that the Wireless TTY Forum was not the appropriate venue to address such issues, because 1) the TTY Forum's primary focus is technical development; 2) many representatives of wireless carriers and manufacturers that attend the TTY Forum meetings do not have the requisite authority to bind their respective companies and the wireless industry on these issues, and 3) these issues transcended the FCC's requirements governing access to 9-1-1 and might implicate the wireless industry's obligations under Section 255. The consumer representatives agreed to meet soon with CTIA's senior staff to discuss the Consumer Requirements Document.

On September 10, 1998, representatives of the consumer groups circulated a document to members of the TTY Forum outlining a new set of criteria to address only functional characteristics of any proposed solution for TTY access to digital wireless systems. The consumer representatives developed this new set of criteria based on new information provided at the September 1998 TTY Forum meeting.[45].

VIII. REGULATORY POLICY ISSUES: FCC COMPLIANCE DATE

On September 11, 1998, CTIA and PCIA sent a letter to the FCC's Wireless Telecommunications Bureau ("Bureau") requesting a three-month extension of the deadline for CMRS carriers' compliance with the Commission's rules governing TTY access to 9-1-1 over digital wireless systems.[46] While the Bureau denied CTIA's and PCIA's request, it suspended enforcement of the rule until November 15, 1998.

Specifically, the Bureau's Order requires the Wireless TTY Forum to develop and provide the Commission, by October 30, 1998: (1) a finalized plan for the testing of digital wireless equipment; (2) a finalized, detailed workplan, approved by all groups participating in the Forum; and (3) CTIA, PCIA and other industry member groups represented in the Forum, must respond to a series of questions set forth in the Extension Order.[47]

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[45] Memorandum from Consumer Representatives to TTY Forum, Sept. 10, 1998. Attached hereto as Appendix R.

The FCC's Wireless Telecommunications Bureau has elevated the new list of criteria by attaching it to the Extension Order as an appendix and holding it out as an example of what consumer groups would like to have incorporated into any solution implemented by the Forum, and therefore the workplan. See Extension Order at 4.

[46] Letter from Andrea Williams, Assistant General Counsel, Cellular Telecommunications Industry Association, and Mary Madigan Jones, Vice President of External Affairs, Personal Communications Industry Association, to Dan Phythyon, Chief, Wireless Telecommunications Bureau, Sept. 11, 1998. See also Letter from Edward Hall and Todd Lantor, Co-Chairs, TTY Forum, to Dan Phythyon, Chief, Wireless Telecommunications Bureau, Sept. 28, 1998 (requesting a three-month extension of the October 1st compliance date). Attached hereto as Appendix S.

At the October 1998 TTY Forum Meeting, Forum members established scheduled milestones for the finalization of the test plan and conducting additional tests. There was significant discussion concerning the recommended time frame, *i.e.,* April – June 1999, for conducting tests. Representatives of the wireless industry explained that this date was based on several factors such as the selection of test laboratories for each digital technologies; queuing up laboratory time, and Y2K testing priority. Consumers and representatives from the FCC, however, expressed grave concern that the wireless industry appeared to be deviating from its proposed course of action under the wireless industry's draft workplan. Suggesting now that and tests could not be conducted until April 1999 prolongs the development of solutions.

Representatives from the wireless industry indicated that April 1999 was a reasonable goal in view of the aforementioned factors, and efforts would be made to commence testing earlier depending upon lab availability. The wireless industry also clarified that such testing will only define the character error rates for each digital air interface and will not determine the appropriate solutions for going forward. There was consensus that the recommended time frame would not preclude industry from continuing its efforts to work on developing viable solutions.

Notwithstanding the wireless industry's assessment, FCC staff in attendance at the TTY Forum 8 Meeting expressed their "extreme displeasure" that the wireless industry did not have information concerning the selection and availability of test labs available for this meeting. In order to make an informed decision as to whether this time frame is acceptable, consumer groups and the FCC staff requested that a representative from each digital technology group contact their appropriate organizations to determine the availability of test laboratories to commence testing prior to April 1999. If test laboratories are limited or not available before this time, the wireless digital technology groups should indicate the reasons. These representatives shall report their findings to the TTY Forum via e-mail as expeditiously as possible. The FCC also requested that the workplan includes such information .

IX. NEXT STEPS

The next Wireless TTY Forum Meeting is scheduled for November 4-5, 1998, in the Washington, DC or Baltimore area. While the TTY Forum plans to submit a final test plan and detailed workplan by October 30, 1998, it was recommended that the agenda for TTY Forum 9 include discussion of additional information or follow-up that may be necessary to assist the FCC in making a determination to extend the compliance date beyond November 15, 1998.

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[47] Extension Order at 4-6.

WIRELESS TTY FORUM WORKPLAN: TTY ACCESS OVER DIGITAL WIRELESS SYSTEMS

Since September 1997, the wireless telecommunications industry (wireless carriers and phone manufacturers), manufacturers of TTY equipment, emergency and relay service provider (9-1-1 and TRS), and consumer organizations that represent individuals who are deaf and hard-of-hearing ("Stakeholders") have undertaken intensive collaborative efforts through the Wireless TTY Forum to develop technically feasible solutions for TTY users to access 9-1-1 over digital wireless systems. To date, the TTY Forum's primary focus has been voice-based solutions in an effort to find an acceptable short-term solution and to meet the FCC's compliance date. The TTY Forum has also proposed several data-based solutions for TTY access to digital wireless systems.

The wireless industry is committed to continuing intensive collaborative efforts to provide viable and practical solutions for TTY access over digital wireless systems not only for 9-1-1 purposes but also to meet the industry's obligations under Sections 225 and 255 of the Communications Act of 1934, as amended. The wireless industry acknowledges that it cannot resolve this issue in a technical vacuum, and that the wireless industry must continue to work cooperatively with TTY manufacturers, the appropriate consumer organizations and organizations representing public safety answering points ("PSAPs") to resolve this issue. Accordingly, the Wireless TTY Forum proposes the following Workplan with scheduled milestones for developing and implementing technical solutions for TTY users to access 9-1-1 over digital wireless systems.

PROPOSED WORKPLAN

I. Assessment of Test Results and Finalization of Test Plan

The TTY Forum has provided preliminary test results and demonstrations on several potential methods for addressing incompatibility between TTYs and the different wireless digital technologies. The TTY Forum developed a uniform test script that manufacturers representing various digital technologies and at least one TTY manufacturer have used in their testing. Test results, however, indicate a wide variance in the character error rate. Furthermore, trying to isolate the cause of the problem within a short time period has been a Herculean yet circumspect task with no conclusive results to date. While the goal is to minimize the character error rate, particularly in 9-1-1 situations, a certain character error rate is inherent with wireline and wireless, both analog and digital technology, and TTY devices.

The co-chairs of the TTY Forum have acknowledged the need for the development of a consistent test methodology, a uniform method of evaluating the test results ("test plan") and TTY performance standards to determine the minimal level of character error rate that TTY users can expect with certain digital technologies used with certain TTY devices.[1]

A. Independent review and assessment of tests conducted to date.

The TTY Forum has requested Dr. Dale Hatfield, Chief of the FCC's Office of Engineering and Technology ("OET") to review and assess the tests conducted to date. It is anticipated that Mr. Hatfield will provide guidance to the TTY Forum on the soundness of the research conducted to date and identify any discontinuity or gaps in such research that should be explored in the development of a standardized test procedure.

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[1] Since the September 1998 TTY Forum, the wireless industry has reviewed the initial test results and has concluded that additional testing would not yield new or significant information on character error rates. The wireless industry has acknowledged that there does not appear to be a voice-based solution in the near future which will allow the Baudot signal of a TTY device to pass through the vocoder of a digital air interface and achieve a character error rate comparable to the character error rate achieved with analog air interface, *i.e.*, less than 1%. Nevertheless, the wireless industry has agreed to conduct further testing to assess character error rates and in accordance with the standardized Test Procedure.

Target Date
Review and assess tests conducted to date -**Task Completed**

B. Finalization of a Standard Test Procedure

The TTY Forum with the assistance of the wireless digital technology groups[2] shall develop a uniform test process designed to limit and control test variables and establish a test methodology yielding better consistency in determining and comparing character error rates ("CER") across the various digital wireless technologies (CDMA, TDMA, GSM 1900, iDEN). Each wireless digital technology group has assumed responsibility for modifying the test process to accommodate testing variances of that technology.

- ◊ Draft Test Procedure – **Task Completed**
- ◊ Submit Test Process to Wireless Digital Technology Groups – **Task Completed**
- ◊ Responses due from wireless digital technology groups regarding modifications, locations of test facilities and test schedules – **10/28/98**
- ◊ Review responses from wireless digital technology groups (Test Plan Sub-task Group) – **10/28/98 – 10/29/98**
- ◊ Submit Test Procedure to FCC and distribute to wireless manufacturers and carriers – **10/30/98**
- ◊ Status Report to TTY Forum – **11/4/98**
- ◊ Review and Feedback on Test Procedures – **TBD by FCC**

C. Conduct additional tests using Test Procedures and compare new results

Each wireless digital technology group shall identify at least one test facility and advise the TTY Forum as to the availability of the test facility in order to commence testing prior to April 1999.[3] Wireless manufacturers and carriers will conduct tests in accordance with the test schedules submitted and return results to

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[2] For purposes of the Workplan, wireless digital technology groups refers to the CDMA Development Group ("CDG"), GSM North America, and Universal Wireless Communications Consortium ("UWC Consortium").

[3] GSM NA has indicated that it plans to commence testing as soon as possible with a target date of January 1999 to provide test results to the TTY Forum and the FCC, provided that the following are true: 1) the test specification with modifications suggested by the GSM NA is approved and released by October 30, 1998; 2) lab based testing with real world conditions is accepted; 3) the test specification does not change dramatically; 4) manufacturers can assist the test facilities to set up the test; and 5) no unforeseen restrictions are placed on the testing.

the TTY Forum and the FCC as soon as available. TTY Forum members shall concurrently continue to research acceptable error rates, voice-based and data-based solutions during the test schedule.

The TTY Forum will provide advance notice to all interested parties of the test dates, location of the test laboratories, and contact person. Technical representatives of TTY manufacturers, Gallaudet University, PSAPs and the FCC are encouraged to participate in the testing and should contact the appropriate manufacturer or carrier conducting the test to discuss participation.

Goals and Target Dates
Refer to Test Procedure for list and availability of test labs and scheduled target dates for conducting the additional tests.

D. Analysis of test results and recommendations

The TTY Forum will appoint a sub-group comprised of representatives from each of the Stakeholder groups. The sub-group will review and analyze the test results and provide specific comments and recommendations to the TTY Forum and the FCC based on the test results.

Goals and Target Date
January 1999

II. User Requirements

Consumer representatives of the TTY Forum have provided the TTY Forum with two documents outlining their criteria with respect to solutions: *Consumer Approved Criteria for Acceptance of 'One Phone Model Per Service Provider as of October 1' Proposal* ("Consumer Criteria Document") and *September 10, 1998 Memorandum from Consumer Representatives to TTY Forum ("September 1998 Consumer Memo").*

A. Consumer Criteria Document

The purpose of the document was to stimulate discussion and solicit the views of the wireless carriers and manufacturers participating in the TTY Forum. At the September 1998 TTY Forum Meeting, CTIA, on behalf of its members, submitted its comments to the criteria set forth in the Consumer Criteria Document.[4] CTIA's senior staff and the drafters of the Consumer

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[4] Letter from Andrea Williams, Assistant General Counsel, Cellular Telecommunications Industry Association, to Ed Hall and Mary Madigan, Co-

Criteria Document shall meet at a mutually agreeable time to address the criteria in the context of CTIA's inter-disciplinary approach to accessibility under Section 255.

Goals and Target Date
Meeting to be held on a mutually agreeable date but no later than December 15, 1998.

B. September 1998 Consumer Memo

On September 10, 1998, representatives of the consumer groups circulated a document to members of the TTY Forum outlining a new set of criteria to address only functional characteristics of any proposed solution for TTY access to digital wireless systems.[5] In accordance with the FCC's Extension Order, the TTY Forum shall consider whether the criteria set forth in the September 1998 Consumer Memo is supported in the proposed voice-based and data-based solutions set forth in this Workplan. Consideration of the criteria shall be documented in a matrix of proposed technical solutions.

Goals and Target Date

- ◊ Develop matrix of proposed technical solutions - **Task completed**
- ◊ Finalize matrix (Task Force Members) - **Task Completed**
- ◊ Submit matrix with Workplan to FCC - **10/30/98**

III. Performance Standards for TTY Devices

Over the past several months, there has been significant discussion concerning the lack of uniform performance standards among TTY devices. Manufacturers of wireless handsets have indicated that such standards are critical in trying to address the technical challenges of voice-based solutions, including passing the Baudot signal of a TTY device over a digital air interface without any modification to the handset

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Chairs, Wireless TTY Forum, Sept. 8, 1998. Attached to October Quarterly Status Report as Appendix Q.

[5] Memorandum from Consumer Representatives to TTY Forum, Sept. 10, 1998. Attached to October Quarterly Status Report as Appendix R.

The FCC's Wireless Telecommunications Bureau has elevated the new list of criteria by attaching it to the Extension Order as an appendix and holding it out as an example of what consumer groups would like to have incorporated into any solution implemented by the Forum, and therefore the workplan. See Extension Order at 4.

or the TTY device. The TTY Forum also discussed the need for a list of "most often used" TTY devices and specifications for each device if TTY manufacturers are not using the EIA Draft Standard. [6] Two TTY manufacturers (Ultratec and Ameriphone) have agreed to identify the typical operating characteristics of the majority of existing TTYs and submit this information as a contribution to the TTY Forum. The TTY Forum will also compile a list of the TTY devices used in the tests. A letter will be sent to a third TTY manufacturer (Krown) again requesting their participation in the TTY Forum, specifically providing typical operating characteristics of its existing TTYs.

Goals and Target Dates

Discussion of TTY manufacturers' willingness to incorporate EIA Draft Standard - **TTY Forum - 9 (11/4/98-11/5/98)**

Submission of document listing typical operating characteristics of the majority of existing TTYs – **Week of 11/9/98**
Letter to third TTY manufacturer – **Week of 11/9/98**

IV. Proposed Technical Solutions

To provide TTY users with a variety of solutions and to allow manufacturers and service providers maximum flexibility to develop innovative technology and services for TTY users, the TTY Forum has posed several voice-based and data-based solutions. The TTY Forum presently does not support any one solution over others. The TTY Forum has developed a matrix of proposed voice-based and data-based solutions. The matrix sets forth the implementation stages, the advantages and disadvantages of each solution, whether the consumer requirements set forth in the September 1998 Consumer Memo are supported, and the corresponding milestones scheduled for each phase of implementation. Please refer to Appendix C: Solutions Matrix and WorkPlan for target dates where applicable.

A. Proposed Voice-Based Solutions

The TTY Forum defines voice-based solutions as those solutions whereby the Baudot signal passes through the Vocoder. Proposed voice-based solutions include connection method solutions such as:

- Direct Audio Connection
- RJ-11-type Modular Connection/Jack (Analog Solution)
- True RJ-11 Connection

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[6] See Electronic Industries Association, Memorandum to Parties Interested in EIA Standards Project PN 1663, Telecommunications Devices for the Deaf, May 16, 1988, 1. Attached to October Quarterly Status Report as Appendix J.

- Acoustic Solution
- Proprietary Solutions

Other proposed voice-based solutions include solutions that may require modification of the Vocoder.

Direct Audio Connection

It appears that coupling via a direct audio connection between the TTY device and a digital wireless handset, *i.e.*, a 2.5 mm audio interface, is a preferred voice-based solution for some wireless carriers. A proposal for a wireless phone 2.5mm audio interface to TTY devices has been submitted to the TTY Forum.[7] The proposal noted that audio output and input levels are different for each make and model phone. Thus, manufacturers of wireless phones would need to provide a special adapter with standard levels. Moreover, audio output and input levels of TTY devices have yet to be defined. The proposal recommended a "common interface" to resolve the variance in output and input levels.[8] While the TTY Forum has reviewed a draft Technical Information Document ("TID"), the TID will be finalized at TTY Forum-9 and will be distributed to manufacturers and carriers shortly thereafter. Members of the TTY Forum will also prepare a Standards Requirements Document ("SRD") for submission to TIA TR45 in early December 1998.

Acoustic Solution

Ericsson has indicated that it plans to pursue this option. Due to the confidential nature of Ericsson's marketing plans for this option, the TTY Forum recommends that the FCC meet with the manufacturer under confidentiality to discuss specific implementation plans and scheduled milestones.

RJ-11-type Modular Connection/Jack (Analog Solution)

The TTY Forum has discussed this option and does not consider it to be a viable short-term solution. Thus, the Forum has not pursued development or implementation of this option.

True RJ-11 Connection

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[7] See Proposed - Wireless Phone 2.5mm Audio Interface to TTY/TDD ("2.5mm Audio Interface Proposal"). Attached to October Quarterly Status Report as Appendix K.

[8] See 2.5mm Audio Interface Proposal at 3-4. Attached to October Quarterly Status Report as Appendix K.

The TTY Forum has discussed this option and does not consider it to be a viable short-term solution. Thus, the Forum has not pursued development or implementation of this option.

Proprietary Solutions

Several proprietary solutions such as the Mobility™ TTY, an enhanced TTY device developed by Lober & Walsh Engineering, the AxCell Interface Device developed by Sendele Wireless Communications and the RangeStar™ Technology developed by RangeStar International, have been presented to the TTY Forum for consideration as solutions. Due to the proprietary nature of these solutions, the TTY Forum has not been privy to how soon these products will be made commercially available. The TTY Forum recommends that that the FCC meets with each company separately and under confidentiality to discuss specific implementation plans and scheduled milestones.

B. Proposed Data-Based Solutions (Circuit-Switched)

The proposed data-based solutions include Inter-Working Function solutions, Third Party Gateway and Proprietary Data-based solutions. The TTY Forum has adopted a SRD for Circuit-Switched Data, which will be submitted to TR45 in early December 1998.

Inter-Working Function Solutions

These solutions rely on the development and installation of the appropriate inter-working function (IWF) software into a wireless carrier's network infrastructure. There are at least two proposed IWF solutions: the V.18 standard and proprietary TTY modems. While the standards for GSM, TDMA, iDEN and CDMA support the IWF functionality, minor modifications are necessary for TTY applications. Implementation of IWF solutions requires completion of product development and deployment, including billing capabilities for data, installation of TTY software in the subscriber terminal, installation of the IWF infrastructure which may be installed per switch or shared among a carrier's switches. In addition, V.18 capable modems need to be manufactured for use in the United States. The estimated timeframes set forth in the Matrix are contingent upon several factors: availability of modems incorporating V.18 standard or other enhanced protocols; timely resolution of any unanticipated technical glitches in product development and deployment as well as installation of the IWF infrastructure; and the availability of the appropriate engineering staff.

The TTY Forum will send a letter to IWF and modem manufacturers notifying them about the TTY Forum's work and the demonstrations of an IWF (V.18) as one type of viable data-based

solutions. The letter will also request information and the projected time period concerning the incorporation of V.18 standard.

Letter to IWF and modem manufacturers: **Week of 11/9/98**

Third-Party Gateway Solution

Another proposed data-based solution is a Third Party Gateway Solution, which is a solution, using the Inter-working function (IWF) but it need not be installed in every carrier's network. A third party vendor would supply a number for a TTY user to call into and then complete the call to a landline TTY using the IWF.

The TTY Forum discussed this option at the November 1998 Forum. The Forum and does not consider it to be a viable solution. Thus, the Forum will not pursue development or implementation of this option.

Proprietary Data-based Solutions

To be reviewed at future TTY Forums.

V. Notification to Subscribers and Potential Subscribers who use TTYs

In compliance with the FCC's rules, wireless carriers have notified subscribers and potential subscribers that they may not be able to use TTYs to access 9-1-1 over digital wireless systems. Wireless carriers, with the support of the wireless trade associations, the consumer advocacy groups, TTY manufacturers and wireless handset manufacturers, will continue to notify subscribers and potential subscribers at appropriate intervals until a product is commercially available.

Goals and Target Date

On-going until product is commercially available.

APPENDIX C

SOLUTIONS MATRIX AND WORKPLAN

Task Force Members to Complete the Data Base Solutions Matrix:

- Todd Lantor
- Norm Williams
- Judy Harkins
- Ron Schultz
- Nikolai Leung
- Mohamed El-Rayes
- UWCC member
- Steve Coston
- John Suprock
- Brye Bonner

Group is empowered to complete matrix below on behalf of the TTY Forum.

PROPOSED VOICE-BASED SOLUTIONS
(Passing Baudot signal through the VOCODER)

Proposed Solution	Testing/ Implementation	Advantages/ Disadvantages	Consumer Requirements Supported	Milestones
Direct Audio Connection (2.5 mm Jack – Preferred Method)	1. Finalize Technical Information Document, 2. SRD, 3. Develop Standard, SDO 4. Notify TTY Phone Manufacturers	Advantages: • Cost effective • Small in size • Rapid to implement • High Immunity to interference • Recognized industry connector • Does not require additional power supply • May allow connection to other devices Disadvantages: • Requires modification/ adapter to TTY • Yields no inherent improvement to CER • Supports only limited features	1. Preferred over acoustic 2. Supported 3. Supported 4. Supported 5. TBD 6. Supported 7. Supported 8. Supported 9. Supported 10. N/A 11. N/A 12. N/A 13. N/A	1. Nov 1998 2. Submit to TR45– Dec 1998 3. Ericsson to identify timetable with TR45actual date to be posted on listserve 4. TBD by #3

Proposed Solution	Testing/ Implementation	Advantages/ Disadvantages	Consumer Requirements Supported	Milestones
RJ11-type Modular Connection/ Jack (Analog Solution)	1. Develop Technical Information Document, 2. SRD, 3. Develop Standard 4. Notify TTY Phone Manufacturers	Advantages: • Could support full functionality • Could support some of the embedded base of TTYs Disadvantages: • Physical size • Cannot use handset for VCO functions (may require separate device for HCO/VCO)	1. Preferred over acoustic 2. Supported 3. Supported 4. Supported 5. TBD 6. Supported 7. Supported 8. Supported 9. Supported 10. N/A 11. N/A 12. N/A 13. N/A	This option is not considered a short-term solution by the Forum and therefore is not being pursued by this Forum at this time.

Proposed Solution	Testing/ Implementation	Advantages/ Disadvantages	Consumer Requirements Supported	Milestones
Acoustic solution – use of external landline handset	1. No Standardiza -tion required	Advantages: • No standardizat ion required • Supports most embedded base of TTYs • Very Low interface cost • Short developmen t cycle • Easily accessible to standardize d landline handsets Disadvantages: • Highly susceptible to background noise • Bulky – requires a landline handset and cable	1. Could negatively impact CER 2. Supported 3. Supported 4. Supported 5. TBD 6. Supported 7. Supported 8. Supported 9. Supported 10. N/A 11. N/A 12. N/A 13. N/A	TBD by manufacturer
Proprietary • Phone Products • Terminal s	Unknown	Unknown	Unknown	Unknown FCC can meet with stakeholders

Proposed Solution	Testing/ Implementation	Advantages/ Disadvantages	Consumer Requirements Supported	Milestones
True RJ-11 Connection	1. Develop Technical Information Document, 2. SRD, 3. Develop Standard 4. Notify TTY Phone Manufacturers	Advantages: • Supports full functionality • Support some of the embedded base of TTYs Disadvantages: • Physical size • Cannot use handset for VCO functions (may require separate device for HCO/VCO) • Requires additional power supply • Expensive • Bulky	1. Preferred over acoustic 2. Supported 3. Supported 4. Not Supported 5. TBD 6. Supported 7. Supported 8. Supported 9. Supported 10. N/A 11. N/A 12. N/A 13. N/A	This option is not considered a short-term solution by the Forum and therefore is not being pursued by this Forum at this time.

Proposed Solution	Testing/ Implementation	Advantages/ Disadvantages	Consumer Requirements Supported	Milestones
Vocoder Modifications		Not cost effective No modification to TTY Using Full rate Extensive international standards development and implementa-tion process. Could provide more reliable CER Potential to degrade voice quality. Error detection and correction would be lower for a data tone call compared to data services.	1. TBD 2. Supported 3. Supported 4. Supported 5. TBD 6. Supported 7. Supported 8. Supported 9. TBD 10. Supported 11. Supported 12. TBD 13. TBD	• Develop new standard. • Test new standard for Baudot and voice.

PROPOSED DATA-BASED SOLUTIONS – Circuit-Switched

Proposed Solution	Testing/ Implementation	Advantages/ Disadvantages	Consumer Requirements Supported	Milestones
Inter-Working Function (IWF): • V.18 (Baudot) • Proprietary TTY Modem	• Complete Data SRD • CDMA existing IS-707 • TDMA existing IS-135 • Standards Modifications TBD based on SRD. • Test with existing TTYs for both inbound and outbound calls. • Test with PSAP, existing TTY using existing standards	Advantages: • Reliable Communications, as good as wireline. • World-wide Standard • Requires little or no modifications to existing TTY • Could support more platforms, TTYs, PDAs, and Laptops. Disadvantages: • Not all Carriers may choose to implement data services. • Compatible with all current Baudot standards, except Ultratec's Turbocode. • Require mobile connection interface to existing TTYs. • IWF do not support VCO • IWF with Baudot not commercially available	1. Supported 2. TBD 3. TBD 4. N/A 5. TBD 6. Supported 7. Supported 8. Supported 9. Not Supported 10. Supported 11. TBD 12. Supported 13. Supported	• Est. Timetable 12-18 months • Implement Baudot/V.18 in the IWF • Widespread deployment of the IWF • Update handsets to support data service.

Proposed Solution	Testing/ Implementation	Advantages/ Disadvantages	Consumer Requirements Supported	Milestones
3rd Party Gateway		Advantages: • Landlines TTY do not need to be modified. Disadvantages • Expensive to operate and maintain.	1. TBD 2. Not Supported 3. Not Supported 4. Supported 5. TBD 6. Supported 7. Supported 8. Supported 9. TBD 10. N/A 11. Not Supported 12. Supported 13. TBD	This option is not considered a viable solution by the Forum and therefore is not being pursued by this Forum at this time.
Proprietary	Unknown	Unknown	Unknown	Unknown FCC can meet with stakeholders

*V.18 Letter to modem manufacturers will be drafted by Dick Brandt under the TTY Forum letterhead requesting support for TTY issue.